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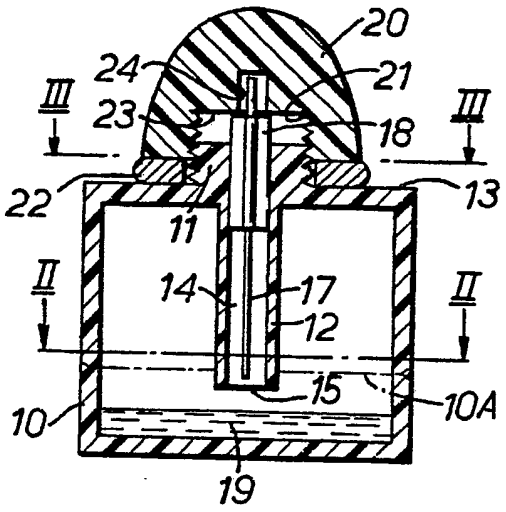
(54) Title: LIQUID SAMPLE COLLECTOR DEVICE

(57) Abstract

A device for collecting and holding a small metered sample of blood or other liquid comprises a length of open-ended capillary tube (17) supported in a holder (18), and a bottle (10) sealed at sub-atmospheric internal pressure by a flexible membrane (15) extends across the lower end of a tubular invagination (12) in the top wall (13) of the bottle. The capillary tube and holder are slidably lowered in the invagination, above the membrane (15), and project upwardly. A threaded cap (20) is screwed onto a neck (11) of the bottle and has a shoulder (23) which when the cap is screwed fully down on the neck, bears on the upper end of the holder (18) and depresses this causing the capillary tube to pierce the membrane so that a blood sample previously drawn into the tube (17) by capillary action will be drawn into the interior of the bottle by suction. A spacer device (22 or 50) removably interposed between the cap (20) and the bottle (10) prevents the inadvertent depression of the tube and holder by the cap. The device can be used to draw a metered blood sample into the capillary tube from a patient's blood spot by capillary action and then to transfer the sample by suction into the bottle by causing the capillary tube to pierce the membrane, which will then seal around the tube circumference to prevent the ingress of air.



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LIQUID SAMPLE COLLECTOR DEVICE

TECHNICAL FIELD

This invention relates to devices and methods for the sampling of small metered samples of liquid.

The invention is particularly although not exclusively applicable to the collection of samples of human blood drawn directly from patients and required for subsequent laboratory analysis or investigation. For example, a sample of capillary blood may be taken from a drop of blood obtained by pricking a patient's finger.

BACKGROUND ART

It is standard practice in clinical work to transfer blood from such a drop into a fine glass capillary tube, which when filled thus contains a metered sample of fresh blood whose quantity is determined by the length and bore of the tube. The blood sample is then required to be transferred into a collection vessel containing a diluent which prevents clotting and deterioration of the blood sample. The collection vessel can then be closed and dispatched to the laboratory for analysis.

Vacuum containers for receiving blood drawn from a patient by means of a hypodermic needle are known. But the safe transfer into a collecting vessel of a small metered blood sample which has been drawn up a capillary tube, presents

practical difficulties.

DISCLOSURE OF THE INVENTION

The present invention in one of its applications is concerned with providing an improved form of sampling and collector device and method for collecting and storing blood samples, the use of which will greatly facilitate the transfer of a blood sample from a capillary tube into a diluent-containing collection vessel.

The invention may however be employed in the collection of small metered samples of any liquid which is capable of being drawn into a length of capillary tube by its own surface tension and which is required to be provided in small quantities for analysis or testing in connection with the improvement or control of any manufacture, for example samples of microbial cultures.

The invention from one aspect comprises a device for use in conjunction with an open-ended capillary tube for collecting a metered sample of liquid, the device comprising a vessel, e.g. a bottle or phial, whose interior is sealed at a sub-atmospheric pressure and whose wall includes a thin perforable flexible membrane, the material and thickness of the membrane being such that it can be pierced by one blunt end of the capillary tube without splitting, and when so pierced will grip and seal circumferentially

around the external surface of the tube.

Preferably, where the capillary tube to be used is of glass, the membrane is made of a flexible synthetic plastics material, for example polyvinyl chloride, polythene or other thermoplastic material. A rubber membrane would be unsuitable since, if thin enough to be pierced by the blunt end of a glass capillary tube without breakage of the tube, it would split and fail to seal around the tube. If the vessel is made of a suitable polythene or other material the membrane may be formed integrally with the adjacent part of the vessel.

The vessel may contain a quantity of other liquid if required, for example of diluent liquid for the sample liquid to be collected, whereby the sample liquid by going into solution or dispersion will be preserved from deterioration in the bottle. The liquid could be a reactant one, chosen to give an immediate colour change when reacted with a constituent of the fluid being sampled and collected.

In one construction the vessel comprises a bottle provided with a tubular formation defining an open-topped well whose lower end defines an opening which leads into the interior of the bottle but is closed by the membrane extending across the said lower end, the well being dimensioned to receive a sampler element

comprising an open-ended length of capillary tube, and a holder in which the tube is mounted with its opposite ends protruding from the respective opposite ends of the holder, the holder being a close sliding fit in the well, and the sampler element being slidably depressible in the well to cause the lower end of the capillary tube to pierce the membrane.

Thus, if a sampler element whose capillary tube contains a metered sample of blood is inserted into the well and is subsequently depressed to pierce the membrane, the sub-atmospheric pressure in the bottle will draw the blood sample from the bore of the capillary needle into the interior of the bottle for storage therein.

In one form of the invention the tubular formation comprises an invagination in the wall of the bottle, for example in its upper wall.

The bottle is preferably transparent and is preferably provided with a removable cap which can be applied to the mouth of the well to close the latter and to enclose a sampler element therein.

The cap itself may be utilized as the means for depressing the sampler element by bearing on the upper end of the holder when the cap is being applied and is approaching its fully-home position closing the well. The

cap may be prevented from reaching its fully-home position by means of a removable spacer element, for example a washer or a hollow internal protective element, which when in position prevents the cap from depressing the element sufficiently for piercing of the membrane to take place.

For example, the cap may be screw-threaded, and may be screwed into or onto a co-operating screw thread formed either on a projecting neck of the bottle which defines at least the mouth of the well, or in the upper end of the well itself, whereby when the cap is being fully screwed down the final portion of its travel depresses the sampler element to cause the capillary tube to pierce the membrane; and the removable spacer element when in position between the cap and the bottle prevents this final portion of the screwing-down travel of the cap.

The bottle itself may be conveniently made of a transparent resilient plastics material, for example polythene or polyvinyl chloride, whereby in a "squeezed condition the resilience of the wall of the bottle creates the sub-atmospheric pressure in its interior.

The invention further comprises the combination of the device referred to, comprising

the sealed vessel, with a length of capillary tube suitable for receiving a sample of the liquid to be tested, for example blood, to be drawn into its bore by capillary action.

The capillary tube may be made of glass, or of some other material having appropriate surface tension characteristics, for example PERSPEX (R.T.M) , and is preferably mounted in the holder as referred to.

According to the present invention from another aspect, a method of sampling liquid comprises applying one end of an open-ended length of capillary tube to a quantity of the liquid to be sampled, to cause a metered quantity of the liquid to be drawn up into the bore of the capillary tube by capillary action, providing a vessel which is sealed at a sub-atmospheric internal pressure and has a thin perforable flexible membrane as a part of its wall, and forcing one end of the filled capillary tube through the membrane, whereby the liquid sample in the capillary tube bore is drawn into the interior of the vessel by the difference between the external and the internal pressure, the material and thickness of the membrane being such that it is capable of being pierced by the end of the capillary tube and, when so pierced, of gripping around the circumferential surface of the capillary tube with a sealing action to prevent significant

ingress of air into the vessel past the exterior of the tube.

The invention includes amongst its advantages the provision of a collector vessel e.g. a bottle, which is initially sealed at a sub-atmospheric pressure, and into whose interior a small metered liquid sample in a capillary tube will be automatically drawn directly and without exposure to the atmosphere by the pressure differential, simply by the action of depressing the sample-containing capillary to cause it to pierce the membrane, which will thereupon seal around the capillary tube to prevent the ingress of atmospheric air into the vessel. In this way the direct transfer of the sample from the capillary tube into the protected interior of the sealed vessel (which may contain a solvent) is facilitated, without risk of clotting, contamination or spilling, and the vessel may be used for storing and/or transporting the sample. Further advantages are that in certain forms of the invention the bottle can be used to support the capillary tube during the actual drawing of a blood sample into the tube from a blood spot; and that the transfer of the blood sample into the interior of the collector bottle can be effected simply by screwing a cap fully back onto the bottle.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be carried into practice in various ways, but two specific embodiments thereof will now be described by way of example only and with reference to the accompanying drawings, in which:-

Figure 1 is a sectional elevation of a blood sample collector;

Figures 2 and 3 are cross-sections on the line II-II and III-III respectively of Figure 1;

Figure 4A is a perspective view of the collector of Figure 1 with its cap and spacer washer in position;

Figure 4B shows the collector with the cap removed and the spacer washer in position;

Figure 4C shows the collector with the spacer washer also removed;

Figure 4D shows the collector with the cap replaced in the absence of the spacer washer, and with the capillary tube in the depressed position projecting through the membrane into the interior of the collector vessel;

Figure 5 is a perspective view of the sampler element;

Figures 6 and 7 are views respectively similar to Figures 1 and 4B, showing a modified embodiment of the invention which employs, instead of a spacer washer, a spacer element

in the form of a rigid hollow inner protective cover to overlie the top of the capillary tube and its holder within the screwed cap; and

Figures 8A and 8B are perspective views respectively from above and below of the inner protective cover in Figures 6 and 7.

BEST MODE OF CARRYING OUT THE INVENTION

The capillary blood collector shown in Figures 1 to 5 of the drawings comprises a collector bottle 10 of oval cross-section made of a moulded resilient transparent plastics material, for example polythene or polyvinyl chloride. The bottle is formed in two parts joined by welding along a suitable weld line and has a screw-threaded neck 11 and an internal tube 12 which projects inwards from the top wall 13 of the bottle 10 below the neck towards the bottom of the bottle 10 to form an invagination. The interior of the tube 12 is a continuation of the bore of the neck 11, and is closed at the lower end of the tube 12 by means of an integral thin plastics membrane 15, extending across the end of the tube 12. The membrane 15 may be of polythene film. The bore of the tube 12 and the throat of the neck 11 together form an open-topped well 14 whose bottom is the membrane 15.

A sampler element 16 comprising an open-ended capillary tube 17 of glass mounted in a

moulded plastics holder 18 is removably inserted into the well 14 in the tube 12, with the lower end of the tube 17 resting above the membrane 15 and with the upper parts of the capillary tube 17 and of its holder 18 projecting above the neck 11 of the bottle 10. The holder 18 is formed with, say, four longitudinal flutes in its sides, giving it a star-shaped cross-section with longitudinal ribs which slide easily in the well 14, reducing friction between the holder 18 and the tube 12 and allowing air to escape along the flutes from the interior of the well 14 when the holder is inserted.

The bottle 10 is sealed during manufacture with the membrane 15 in position and with its interior at a sub-atmospheric pressure, produced by squeezing the bottle prior to and during its sealing so that the resilience of the walls of the bottle when they attempt to relax after it has been sealed produces a reduction in pressure in its interior. The bottle 10 contains a measured quantity of selected diluent liquid 19, the choice of which depends upon the blood analysis or tests which are to be performed on a blood sample when collected in the device and dispersed in the diluent.

A substantially rigid moulded cap 20 with an internal screw thread 21 is provided together with a removable spacer washer 22. A circum-

ferential shoulder 23 in the interior of the cap 20 defines a central recess 24 to receive the upper end of the capillary tube 17. When the cap 20 is screwed down onto the neck 11 with the spacer washer 22 in place, and with a sampler element 16 positioned in the well 14 with its lower end above the membrane 15 as shown in Figures 1 and 4A, the upper end of the capillary tube 17 enters the recess 24 in the cap 20 and the shoulder 23 overlaps the upper end of the holder 18 but without engaging it. However, if the spacer washer 22 is removed from around the neck 11 (Figure 4C) the cap can be screwed further down until the shoulder 23 bears down on the upper ends of the four longitudinal ribs of the holder 18 to depress the sampler element in the well 14 and force the blunt lower end of the tube 17 through the membrane.

Longitudinal grooves 25 are formed in the exterior of the neck 11, intersecting the screw thread on the neck, to act as vents to the capillary tube 17 in the central recess 24 of the cap 20, via the flutes in the holder 18, when the cap 20 is being screwed down.

The device is supplied with a clean sampler element 16 in the well 14, and with the washer 22 in position and the cap 20 screwed down onto the washer, as shown in Figures 1 and 4A, to protect the sampler element from

damage and contamination. The cap 20 and the capillary holder 18 may be colour-coded to indicate the particular diluent liquid which is contained in the bottle 10.

To use the device, the cap 20 is unscrewed and the spacer washer 22 removed. A patient's finger or some other part of the skin is pricked to produce a drop of fresh blood, and the upper end of the capillary tube supported in the well 14 of the bottle and protruding from the neck 11 is placed in the drop by an operator holding the body of the bottle, so that a metered quantity of the blood is taken from the patient and is drawn into the bore of the capillary tube by capillary action due to surface tension. The capillary tube can be viewed through the transparent bottle 10 and tube 12, so that the operator can see when the tube 17 is filled. An indicator line 10A on the wall of the bottle 10 opposite the lower end of the tube, for example formed as a weld line, would assist the operator in seeing the end of the tube to judge when it is filled. The cap 20 is then replaced, and in the absence of the spacer washer 22, the cap can be screwed down further onto the neck 11 so that the shoulder 23 engages the upper ends of the ribs on the holder 18 and depresses the element 16 in the well 14, driving the lower end of the capillary tube 17 through

the membrane 15; the rim of the aperture thus pierced through the membrane will grip resiliently around the circumferential surface of the tube 17 thus sealing it and preventing the ingress of air past the outside of the tube.

The sub-atmospheric pressure in the interior of the bottle 10 draws the blood sample from the capillary bore of the tube 17 into the bottle 10 where it mixes with the diluent liquid. The vent grooves 25 in the screw-thread on the neck 11 of the bottle allow air to pass into the interior of the cap 20 and, via the flutes of the holder 18 and the recess 24, into the upper end of the capillary tube to replace the blood being sucked into the bottle, as the cap is being screwed down. When the cap is finally screwed down firmly onto the top wall 13 of the bottle, as shown in Figure 4D, it seals the bottle against the escape of its contents, as well as covering those parts of the container neck and the capillary tube and holder which may be contaminated with blood. The closed bottle can now be despatched to the laboratory where appropriate analysis of the diluted blood contained in it can be carried out.

As an example of a suitable material and thickness of the membrane 15, this may be a polythene membrane of 125μ m (500 gauge). This is suitable for use with a glass capillary tube

of 20µl capacity, 28.5 mm. long with an internal diameter of 0.83 mm and a wall thickness of 0.2 mm. The optimum thickness of the membrane 15 will depend upon the material of the membrane and the external diameter of the capillary tube to be used. The practical minimum and maximum limits of thickness of a polythene membrane are approximately 65µm (250 gauge) and 250µm (1000 gauge). A thinner membrane will be too fragile, and one of greater thickness than 250µm will be too firm. A capillary tube of larger cross-section, e.g. 1.2 mm. internal diameter and wall thickness 0.2 mm, can be used with a polythene membrane up to say 125µm, but not with a thicker polythene membrane as it would punch a hole in the membrane which would not grip resiliently around the exterior of the capillary tube to seal it.

The bottle 10 instead of being resilient could be made of rigid glass or plastics material, sealed under a sub-atmospheric pressure.

Figures 6 to 8B show a modification of the device of Figures 1 to 5 in which no spacer washer 22 is provided between the screwed cap 20 and the wall 13 of the bottle 10, but instead a removable hollow internal protective cover element 50 is provided as a spacer device. In Figures 6 and 7 the same reference numerals as in Figures 1 to 5 are used for corresponding parts.

The internal protective cover 50 is shown in detail in Figures 8A and 8B, and is made of substantially-rigid plastics material, for example an acrylic plastic such as PERSPEX (R.T.M.). It has a cylindrical side wall stepped at 51, with a closed upper end 52 and a radial flange 53 at its lower end. In use, the protective cover fits over the upper part of the holder 18 and over the protruding upper end of the capillary tube 17 when the sampler element 16 is in position in the well 14 above the unperforated sealing membrane 15. The flange 53 of the cover 50 rests on the top of the neck 11 of the bottle, and its step 51 provides an abutment against which the shoulder 23 of the cap 20 abuts, to prevent the cap being screwed down sufficiently to depress the sampler element 16. In this position the protective cover 50 also protects the exposed upper end of the capillary tube from contamination or damage when the screw cap 20 has been removed.

For use, the screw cap 20 is unscrewed from the bottle neck 11 and is removed, and the inner protective cover 50 is then removed from its position covering the sampler element 16. A blood sample is then drawn into the capillary tube as previously described, and the screw cap 20 is then replaced without the protective cover 50 in position. The screw cap 20 is then screwed fully down to depress the

sampler element 16, piercing the membrane 15 so that the blood sample is transferred into the interior of the bottle as already described with reference to Figures 1 to 5.

Where the resilient plastics bottle 10 of either of the illustrated embodiments has been sealed in a "squeezed" condition during manufacture, as described, it may be found that if the device is kept in store for a prolonged period before use, air will permeate through the plastics wall of the bottle allowing its wall to relax and the internal air pressure to approach atmospheric. To enable the necessary pressure differential to be re-established, the bottle may be designed to be "re-squeezed" before use. For this purpose the bottle may be provided with a simple one-way check valve, e.g. of ball or flap type, which will allow the discharge of air when the bottle is squeezed and will close when the bottle is released; or with a removable wall portion or a removable air-tight plug in its wall, which can be temporarily removed (with the bottle held in such an attitude that its liquid contents will not escape), allowing the bottle to be squeezed, and can then be replaced to reseal the bottle before the squeezing force is relaxed.

For example, the top portion of the bottle including the neck with the screw cap and the sealed inwardly-projecting tube 12 containing the sampler

element may be removable as a unit from the top wall of the bottle; or the bottle may be provided with a removable lower end portion. A suitable screwthreaded or "snap-on" air-tight connection with the remainder of the bottle will be provided for such removable top or bottom portion of the bottle.

Alternatively the bottle may be made of an impervious rigid material such as glass, and be sealed in manufacture at the required sub-atmospheric internal pressure, as described, thereby avoiding any problem of loss of vacuum in storage.

INDUSTRIAL APPLICABILITY

As has already been indicated the invention is capable of industrial exploitation in the field of devices for surgical or medical use, and provides a method and device for use in sampling and storing small metered blood samples, or other liquid samples, e.g. of microbial cultures, prior to analysis; and also in the use of similar devices in other industrial fields where small metered samples of industrial liquid are required to be taken and stored in a protected condition.

CLAIMS

1. A device for use in collecting a metered sample of liquid, the device comprising a sealed vessel (10) whose interior is at a sub-atmospheric pressure, the device being charaterised by being for use in conjunction with an open-ended capillary tube (17) and in that the wall of the vessel (10) includes a thin perforable flexible membrane (15), the material and thickness of the membrane being such that it can be pierced by a blunt end of the capillary tube without splitting, and when so pierced will grip and seal circumferentially around the external surface of the tube.

2. A device as claimed in Claim 1, characterised in that the membrane (15) is of polythene.

3. A device as claimed in Claim 1 or Claim 2, characterised in that the membrane (15) is formed integrally with the adjacent portion (13) of the vessel.

4. A device as claimed in Claim 1 or Claim 2 or Claim 3, characterised in that the vessel (10) comprises a bottle provided in its wall with a tubular formation (12) defining an open-topped well (14) whose lower end is closed and separated from the interior of the bottle by the membrane (15) extending across the said lower end, the well being dimensioned to receive a sampler element (16) comprising a capillary tube (17) formed with an

open-ended capillary bore and a holder (18) in which the capillary tube is mounted to protrude in opposite directions, the holder being a close sliding fit in the well, and the sampler element being slidably depressible in the well to cause the lower end of the tube to pierce the membrane.

5. A device as claimed in Claim 4, characterised in that the tubular formation comprises an invagination (12) in the wall of the bottle.

6. A device as claimed in Claim 5, characterised in that the invagination (12) is provided by a cylindrical tubular formation which projects inwardly from the internal surface of the outer wall (13) of the bottle into its interior, the lower end of the tubular formation being closed by the membrane (15), and its upper end joining the outer wall (13) of the bottle around an aperture therein which forms an upper part of the well.

7. A device as claimed in Claim 6, characterised in that the cylindrical tubular formation is formed integrally with the wall of the bottle which it joins.

8. A device as claimed in any one of Claims 4 to 7, characterised in that the bottle is provided with a neck (11) which projects outwardly from the wall (13) of the bottle, the neck having a throat which affords at least the upper end of the well (14).

9. A device as claimed in any one of Claims 4 to 8, characterised by a removable cap (20) which can be applied to the mouth of the well (14) to close the latter and to enclose the sampler element (16) therein.

10. A device as claimed in Claim 9, characterised in that the cap (20) also comprises a means for depressing the sampler element (16) in the well (14) to effect the piercing of the membrane (15).

11. A device as claimed in Claim 10 characterised in that the cap (20) when moved into its fully-home position on the bottle (10) closing the well (14) depresses the sampler element (16) to effect the piercing of the membrane (15), and which includes a removable spacer member (22 or 50) which is capable of being positioned between the cap (20) and the bottle (10) and which when in position prevents the cap (20) from reaching its fully-home position.

12. A device as claimed in Claim 10 or Claim 11 characterised in that the cap (20) is screw-threaded (21) and is adapted to be screwed onto or into a cooperating screwthread on a part (11) of the bottle surrounding the mouth of the well (14), the cap depressing the sampler element (16) to effect the piercing of the membrane (15) during the final part of its travel on being screwed into its fully-home position on the cooperating thread.

13. A device as claimed in Claims 11 and 12 characterised in that the cap (20) is internally screw-threaded (21) and fits into a cooperating external screwthread on the neck (11).

14. A device as claimed in Claim 13, characterised in that the screwthread on the neck (11) or in the cap (20) is formed with an axial groove (25) for venting the interior of the cap when it is being screwed onto the neck.

15. A device as claimed in any one of Claims 12 to 14 characterised in that the cap (20) is formed with an internal shoulder (23) which is arranged to overlap and bear onto the upper end of the holder (18) of a sampler element (16) introduced into the well (14) and, when the cap is screwed into its fully-home position on the cooperating screw-thread, to force the holder inwardly and effect the piercing of the membrane (15).

16. A device as claimed in Claim 15 characterised in that the cap is formed with a vented central recess (24) in its interior beyond the shoulder, into which recess the projecting upper end of the capillary tube (17) enters when the cap is screwed fully home.

17. A device as claimed in any one of Claims 3 to 16 in which the vessel comprises a bottle (10) whose wall is formed at least in part of a resilient

plastics material, and is closed or sealed in a resiliently-deformed ("squeezed") condition of reduced volumetric capacity whereby the resilience of the deformed wall of the bottle creates the sub-atmospheric pressure in its interior.

18. A device as claimed in any one of Claims 1 to 17 characterised by being in combination with a length of open-ended glass capillary tube (17), the dimension of the bore of the capillary tube being suitable for drawing up a sample of fresh blood by capillary action, and the external dimension of the tube being such that one end is capable of piercing the membrane (15) without rupturing it.

19. The combination claimed in Claim 18 characterised by a device as claimed in any one of Claims 4 to 17, and in which the capillary tube (17) is mounted in a holder (18) from opposite ends of which the end portions of the tube protrude, the tube and its holder comprising a sampler element (16) which is constructed and arranged to be introduced longitudinally into the well (14), and, when depressed therein, to pierce the membrane (15).

20. The combination claimed in Claim 19, characterised in that the holder (18) is formed with a plurality of longitudinally extending flutes in its circumferential surface, said flutes defining between them longitudinal ribs whose crests slidingly engage the sides of the well (14).

21. The combination claimed in Claim 19 or Claim 20, characterised by a device as claimed in any one of Claims 11 to 16, and in which the sampler element (16) is dimensioned to be depressed to pierce the membrane (15) by the engagement of the cap (20) with the upper end of the holder (18) of the element during the final part of the travel of the cap when being screwed down on the cooperating screwthread.

22. The device or combination claimed in any one of Claims 1 to 21 in which the vessel (10) contains a quantity of blood diluent liquid.

23. A method of sampling liquid, comprising applying one end of an open ended length of capillary tube to a quantity of the liquid to be sampled, to cause a metered quantity of the liquid to be drawn up into the bore of the capillary tube by capillary action, the method being charaterised by providing a device as claimed in Claim 1 and forcing one end of the filled capillary tube (17) through the membrane (15), whereby the liquid sample in the capillary tube bore is drawn into the interior of the vessel (10) by the difference between the external and the interior pressure, the material and thickness of the membrane being such that it is capable of being pierced by the blunt end of the caplliary tube and, when so pierced, of gripping around the circumferential surface of the capillary

tube with a sealing action to prevent significant ingress of air into the vessel past the exterior of the tube.

24. A method as claimed in Claim 23, characterised in that the membrane is made of flexible synthetic plastics material, for example polyvinyl chloride, polythene or other thermoplastic material.

25. A method as claimed in Claim 23 or Claim 24, characterised in that the capillary tube is made of glass.

26. A method as claimed in any one of Claims 23 to 25 characterised in that the liquid to be sampled is blood and that the vessel contains a quantity of diluent liquid in which the blood sample becomes dispersed.

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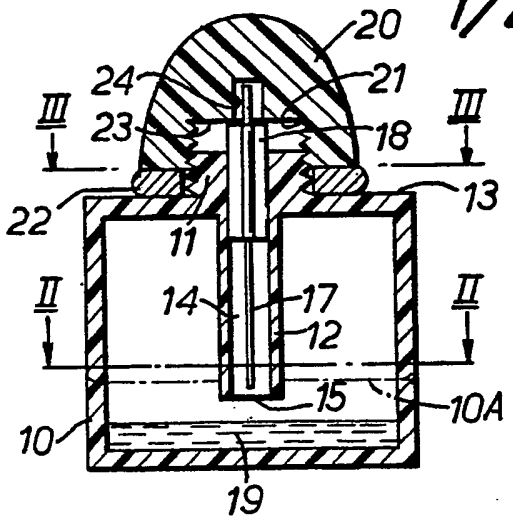

FIG. 1.

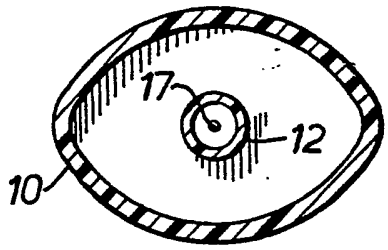

FIG. 2.

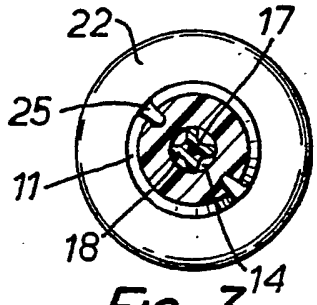

FIG. 3.

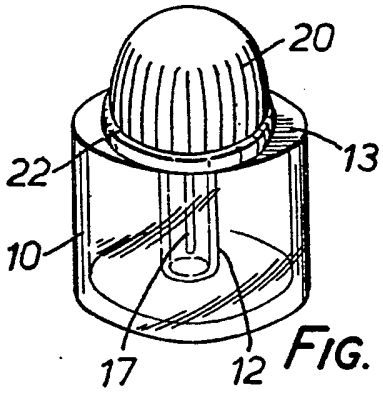

FIG. 4A.

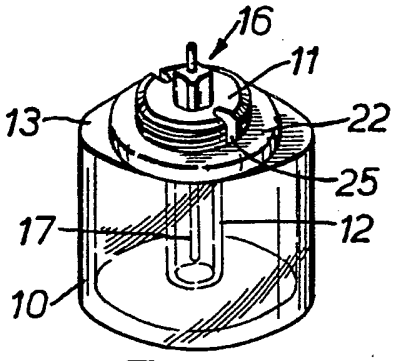

FIG. 4B.

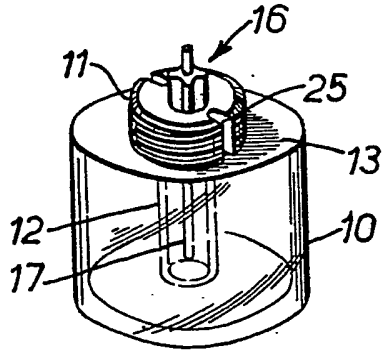

FIG. 4C.

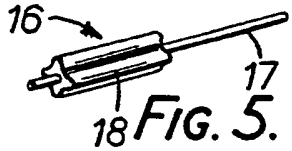

FIG. 5.

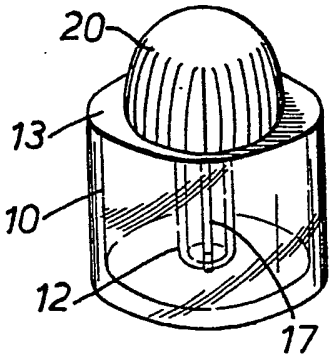

FIG. 4D.

2/2

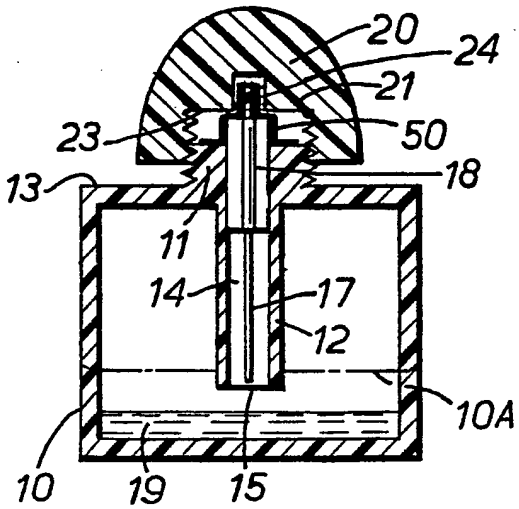

FIG.6.

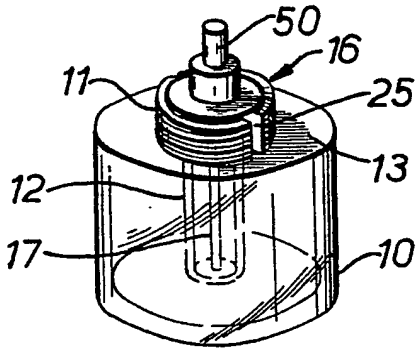

FIG.7.

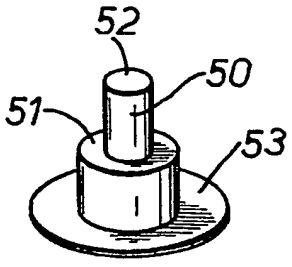

FIG.8A.

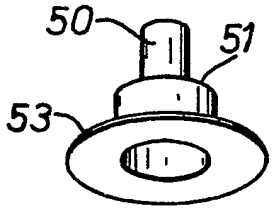

FIG.8B.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 79/00077

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

A 61 B 5/14; B 01 L 3/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int.Cl.[2]	A 61 B 5/14; B 01 L 3/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
	US, A, 3123073, published March 3, 1964, see column 1, lines 16-28; column 2, lines 10-64; column 3, lines 21-43 and figures 2,3,5,6, C.H. Barr, Sr. et al.	1,3,11,23
	GB, A, 1468801, published March 30, 1977, see page 1, lines 33-84; page 2, lines 44-103; page 3, lines 15-25 and figures 1 + 2, Accu-Tech. Ltd.	1,3-7,22, 24,26
	US, A, 3931815, published January 13, 1976, see abstract; column 2, line 10 - column 3, line 61 + figure 1, N. Takatsuki/Jintan Terumo Company Ltd.	1,3,11,22, 24,26
	GB, A, 1036000, published July 13, 1966, see page 1, lines 9-77; page 2, lines 10-78 and figures 1-3, S + R.J. Everett + Company	1,9,10,12, 13,15,21,23
	US, A, 3500821, published March 17, 1970, see column 2, lines 18-20; column 3, lines 10-37 and figures 1 + 2, R.W. Ogle/Asper-Vac Corp.	1,3,10,12, 13,15,21,23
	US, A, 3045494, published July 24, 1962,	1,17,18,22, ./.

* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
16th August 1979	24th August 1979
International Searching Authority [1]	**Signature of Authorized Officer [20]**
European Patent Office	G.L.M. Kruydenberg

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

	see column 1, line 56 - column 3, line 20; column 4, line 40 - column 5, line 14 and figures 1-3,8,9, H.W. Gerarde	25,26

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ....., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the International application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.